SPECTRASENSORS
Precision Laser Technology

Model 2000 Series Operators Manual

Model 2000 Series

Table of Contents

Service Contact

If the above troubleshooting steps do not result in a resolution of the problem, you should call the sales representative that sold it to you. Always contact your sales representative before returning units to factory. The representative can help with additional troubleshooting procedures and can diagnose whether the unit can be serviced on-site or should be returned to the factory for repair. Your sales representative is:

Introduction

About SpectraSensors

SpectraSensors is located in Altadena, California, just a short distance from the California Institute of Technology's Jet Propulsion Laboratory (JPL) where the basic technology behind the products offered by SpectraSensors was developed. This technology was first utilized for accurate measurements of gases in the Earth's atmosphere in the early 1980s, and recently was incorporated into miniaturized and space-qualified instruments for Mars research. SpectraSensors obtained the commercial rights to this NASA technology, and is now offering state-of-the-art gas sensors.

About the Model 2000 Series Gas Sensor

The 2000 series of gas sensors are Tunable Diode Laser (TDL) absorption spectrometers operating in the near infrared wavelength region. Each 2000 sensor contains a TDL light source and detector configured to allow high sensitivity in a compact package, microprocessor-based electronics, and software incorporating advanced operational and data processing algorithms. This manual will use the two-channel system as a reference for description. All comments also apply to the single channel sensors, except where indicated.

The 2000 Series is designed for use at natural gas sampling stations, extractive analysis installations, or wherever fast response and high accuracy measurements are required over a wide measurement range. It is a high performance instrument, capable of measuring moisture and carbon dioxide in methane and other gases without regard to corrosive gases and contamination from other gas phase constituents in the stream.

Several patents protect the TDL absorption technology incorporated in SpectraSensors' gas analyzers.

Theory of Operation

Both H_2O and CO_2 are measured by monitoring their absorption of laser light at specific wavelengths in the near-infrared (near-IR) wavelength region near 2μm. The human eye responds to light in the range of approximately 0.4μm (deep violet) to 0.8μm (deep red), but most molecules “respond” to light at longer wavelengths that are invisible to the human eye (the infrared region). By using a laser that operates precisely at a wavelength where H_2O, or CO_2, (many other gases can also be measured using this technique) absorbs, it is possible to accurately determine the abundance of the gas by measuring the amount of light that is absorbed by the molecules.

SpectraSensors’ can provide references that describe in detail how our gas sensors operate. However, a detailed description is beyond the scope of this user manual.

Specification Sheet for the 2000 Series Analyzer

Table 1 Specification sheet

Measurement Range	
Moisture Concentration (H_20)	0 to 20 lbs/MMscf
Dew/Frost Point	-70 to +-30 °C (-94 to -22°F)
Carbon Dioxide (CO_2)	0 – 10%
Reading Accuracy (H_2O)	± 2% of reading, or ±4 ppmv, whichever is greater
Reading Accuracy (CO_2)	± 2% of reading, or ±400 ppmv, whichever is greater
Response time	1 second continuous updates (software adjustable)
Normal operating environment range	
Temperature	-20 to +50°C (-4 to +122°F)
Pressure	0.7 to 1.7 Bar (10.3 to 25.0 PSA) 3 Bar (30 PSIG) absolute maximum
Gas flow rate	0.3 to 10 Liter/minute
Glycol contamination sensitivity	None for gas phase glycols
Sample cell construction	300 series polished stainless steel
Input Voltage	100-250 VAC, 50-60 Hz standard
Current draw @ 120 VAC	1 amp maximum
Outputs	
Moisture, dew point, CO_2 %, pressure, and temperature	4 line LCD display RS-232 serial port 4-20 ma current loop (concentration only)
Data Input	16-key keypad
Weight	25 lbs (11.5 kg)
Dimensions (box)	Wide: 18.8-in. (478-mm) Deep: 5.3-in. (135-mm) Height: 17.5-in. (444-mm)

NOTE: These are typical specifications. Exact performance will vary depending on installation and operating environment.

Installation

Introduction

The 2000 Series is a compact unit designed to provide years of accurate, dependable gas monitoring. All of the electronic controls are contained inside a NEMA 4X stainless steel enclosure.

The 2000 Series contains one or two sensitive measurement heads (depending on number of target gases analyzed). Each consists of a gas sample cell and an optical head assembly. Inside the optical head assembly is a tunable diode laser and optical components that should be handled with extreme care.

 **CAUTION! – Do not hold or carry the unit by the measurement heads or sample cells. Doing so may cause optical alignment problems affecting the performance of your sensor.**

Key Hook-up Details

Gas Connection	¼" O.D. Tube
Power Cord Diameter	0.31" to 0.56"
Signal Cable Diameter	0.31" to 0.56"
Conduit Knock Hole	½" K.O.

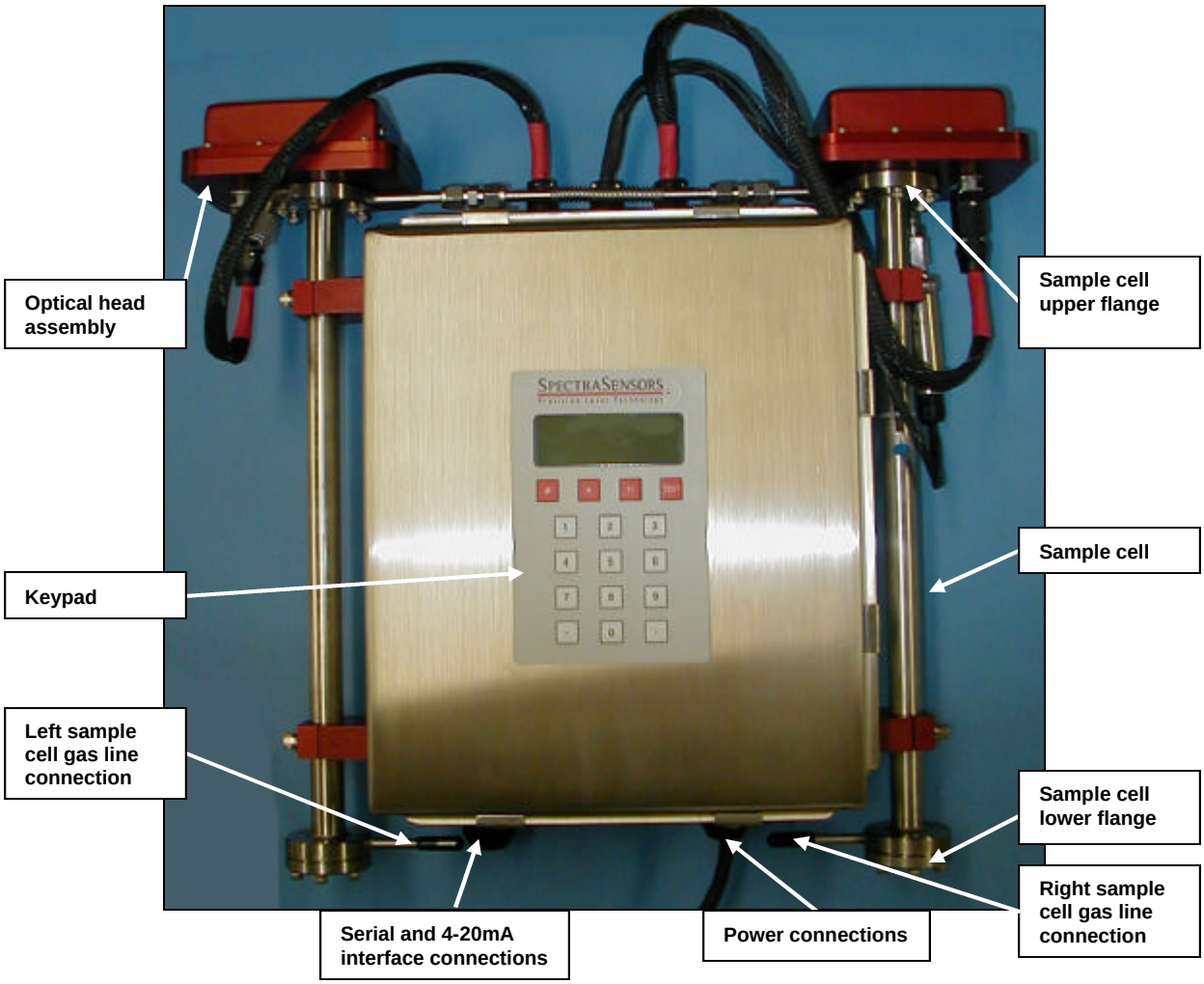


Figure 1 Main external components identified on 2000 Series gas sensor.

Initial Inspection

The 2000 Series should be inspected for damage. The contents of the container should include:

- The 2000 Series stainless steel enclosure with measurement leads
- Operators Manual

Inspect the unit for dents or dings in the enclosure and keypad. Inspect the inlet and outlet connections for damage. Report any damage to the shipping agent.

-

Location Requirements

- AC power (100-250VAC, 50/60 Hz). The 2000 Series is equipped with a universal power supply that will accommodate both US (110 VAC @ 60 Hz) and European (250 VAC @ 50Hz) AC power configurations
- Mounting surface: wall-mounted, or tabletop mounted.

- Sampling lines with coalescing and particulate inline filters and shutoff valve on inlet line
- Ambient temperature: -4°F (-20°C) to 122°F (50°C)
- Ambient pressure: 10 PSIA to 16 PSIA (sample cell pressure: 10 - 25 PSIA)

Mounting Procedure

The 2000 Series is designed to be bolted to a wall or other flat surface that is free of vibrations. Minimizing the gas volume of the sample system and using stainless steel tubing optimizes performance. The only critical mounting issue is to mount the unit so that the inlet and outlet line will reach the inlet and outlet connections on the chassis and still have some flexibility (i.e. the sample lines will not be under excessive stress).

To wall mount the 2000 Series gas sensor:

1. Unpack the 2000 Series from the shipping container. **Be careful not to shock the instrument by dropping it or banging it against a hard surface as this could disturb the optical alignment.**
2. The 2000 Series has 4 mounting tabs with a 0. 3-in. hole in each tab (see Figure 2). SpectraSensors recommends using ¼" lag bolts (or ¼-20 machine screws if through bolted).
3. Position the unit where desired.
4. Mark the hole in one of the top tabs with a pencil.
5. Mark a second top screw location 8" over from the first.
6. Mark the lower screw locations 12-3/4" below the top holes.
7. Drill the appropriate size hole for the screws being used.
8. Hold the unit in place and insert the top screws.
9. Insert the bottom screws and tighten all four screws. The unit should be very secure.
10. The unit is now ready to receive the inlet and outlet sampling gas lines.

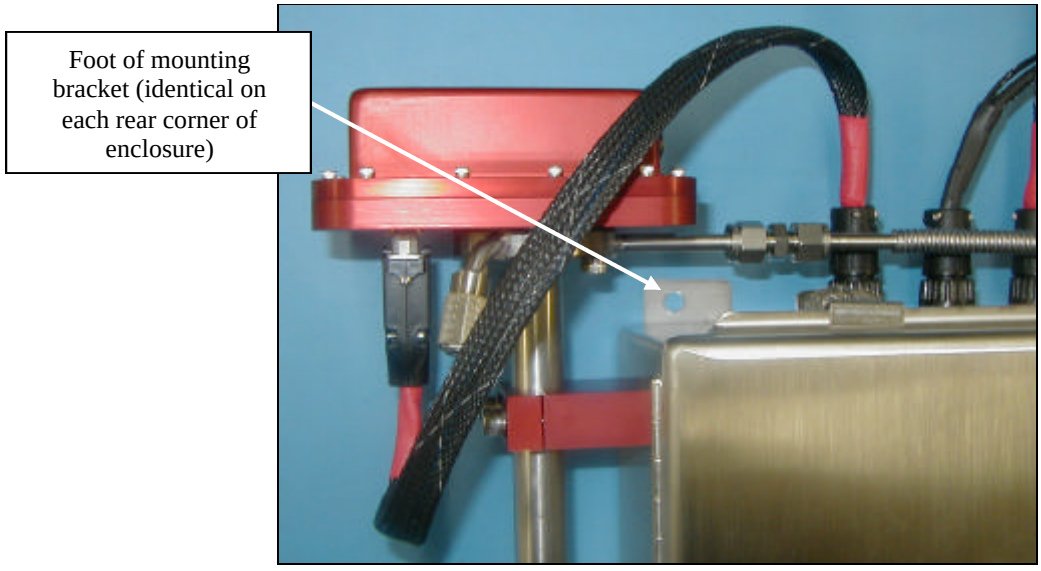


Figure 2 Main external components identified on 2000 Series gas sensor.

Gas Line Connection Procedure

The 2000 Series is configured to accept ¼" O.D. sampling lines (inlet and outlet) via compression fittings mounted on the chassis.

 **CAUTION! – The inlet line should be equipped with a membrane or coalescing filter to prevent liquid from entering the sample cell and possibly accumulating on the internal optics.**

It is important that the internal optical elements remain clean for proper readings. The inlet line should also have a shutoff valve to prevent gas flow into the analyzer when it is not in use. The outlet line of the 2000 Series is connected to a ¼-in. O.D. stainless steel line that vents the sampled gas to ambient air outside the sampling station. After the inlet and outlet lines have been connected, the connections should be checked for leaks. The minimum flow rate through the analyzer should be 0.3 liters per minute (L/min). Optimum sample cell pressure is just above ambient pressure for the installation location. Sample cell pressure is displayed on the front panel LCD.

 **CAUTION! – The pressure in the sample cell must not exceed 30 PSIG (3 Bar A). Higher pressures will cause catastrophic damage to the instrument. We recommend that there be no restrictions in the output vent line of the sample cell and that a pressure relief valve be used on the input line in case of regulator failure.**

To make the gas line connections:

1. To avoid initial contamination entering the analyzer, establish the gas flow and blow any contamination from the line before connecting.
2. Align the inlet and outlet tubing to gas sensor inlet and outlet connections.
3. Be sure that there is no stress on the tubing when it is aligned to the gas sensor.
4. Install union type swage fittings to connect the inlet and outlet tubes to the gas sensor.
5. Follow manufacturer's recommended procedure for tightening the fittings.
6. Open the shutoff valve on inlet line.
7. Check the connections for gas leaks.

Electrical Power Connection Procedure

Electrical power can be connected to the unit with either a power cord or through a conduit. A ½" knockout is provided at the lower right of the unit to accomplish this. The 2000 Series is equipped with either a universal power supply that will accommodate both US (115 VAC @ 60 Hz) and European (240 VAC @ 50Hz) AC power configurations or a DC input power supply.

CAUTION! – Before attempting to attach the power wiring to the gas sensor, be sure that there is no power present on the wires.

To connect an electrical power cord to the unit:

1. Open the enclosure door, being careful not to disturb the electrical assembly inside.
2. Thread a 120VAC power cord through the strain relief fitting supplied with the unit. See figure 3. The power cord must be the three wire grounding type. The power cable should have at least 16 gauge conductors. The strain relief fitting is designed to accommodate cords with outside diameters from 0.31" to 0.56".

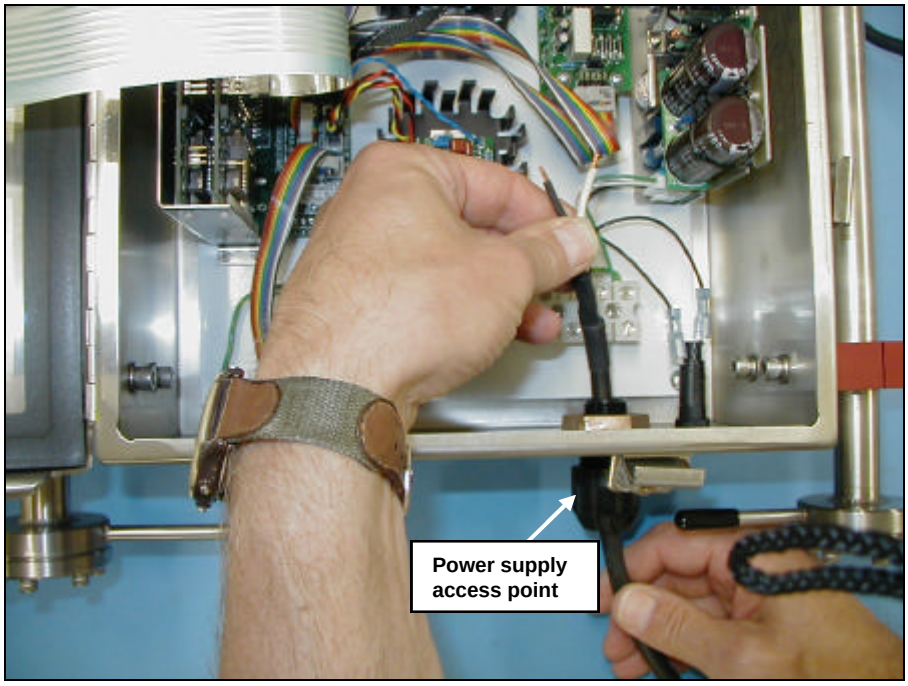


Figure 3 Thread power supply through the right side access point at the bottom of the enclosure.

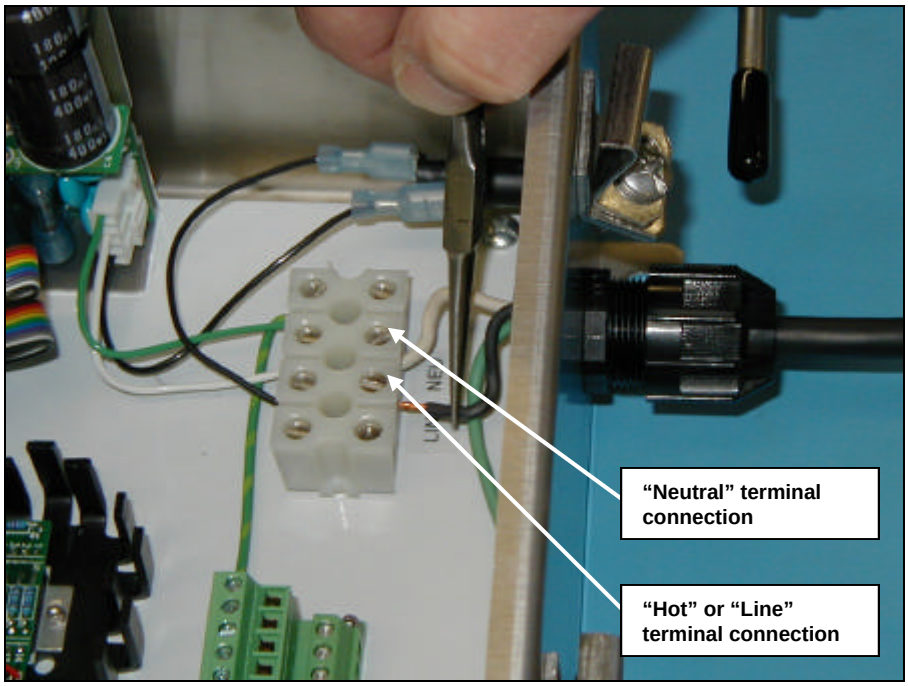


Figure 4 Connect neutral line to terminal marked "NEU", and hot line to terminal marked "LINE".

3. Remove at least 8" of the jacket to expose the three conductors within.
4. Cut the black wire (line or hot) and the white wire (neutral) about 2" from the jacket and strip off 3/8" of insulation from the ends.
5. Loosen the terminal screw marked LINE, insert the black wire, and tighten the terminal screw. Be sure that the terminal is contacting the conductor and not clamped onto the insulation. See figure 4.
6. Loosen the terminal screw marked NEU, insert the white wire, and tighten the terminal screw. Be sure that the terminal is contacting the conductor and not clamped onto the insulation.
7. Crimp a #10 ring terminal to the green (ground) wire in the cord. Be sure that the terminal is the correct size for the gauge of wire being used and the crimp holds both the insulation and the wire. Follow the terminal manufacturer's instructions for preparing and crimping the terminal.
8. Remove the grounding screw at the bottom right of the electrical panel. See figure 5. Insert the screw through the ring terminal on the green wire of the power cord, through the ring terminal of the internal grounding wire, and tighten it into the panel.

CAUTION! – Failure to properly ground the gas sensor can create a high voltage shock hazard. Follow the instructions carefully.

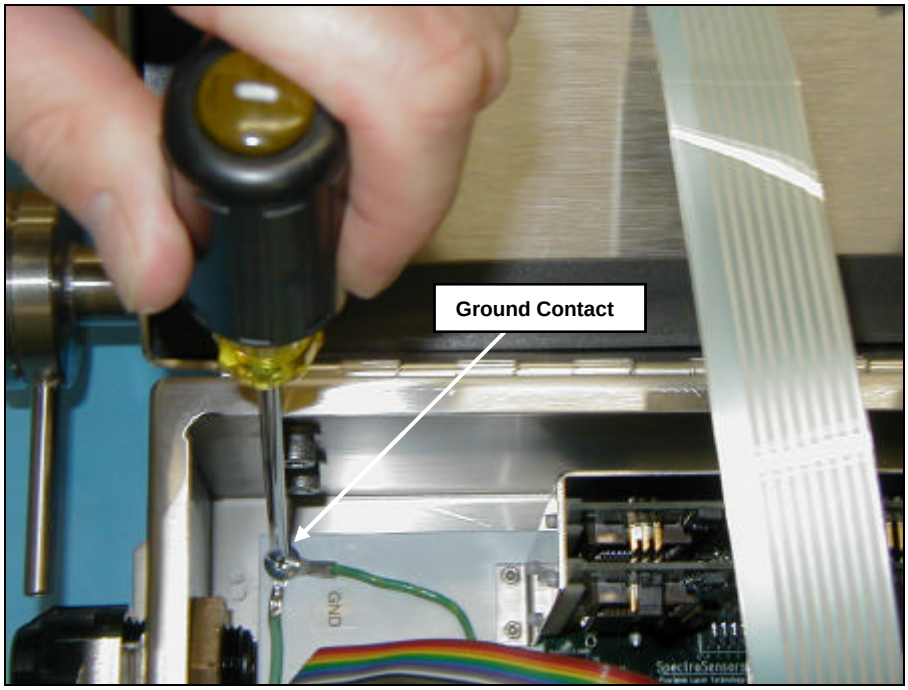


Figure 5 Connect the green wire to the ground contact in the lower left corner of the enclosure.

9. Tighten the strain relief mechanism so that it is grips the power cord.
10. Close and lock the enclosure door.
11. Plug the power cord into an AC socket. The socket should be fused for 15A or less. Because the plug on the power cord is the primary power disconnect means, the AC socket must be located within 10 ft of the gas sensor.

To hardwire power to the unit through a conduit:

CAUTION! – Before attempting to attach the power wiring to the gas sensor, be sure that there is no power present on the wires.

1. Open the enclosure door, being careful not to disturb the electrical assembly inside.
2. Remove the cord strain relief fitting from the power knockout.
3. Replace the strain relief with a NEMA 4X rated conduct hub.
4. Run conduit from the AC panel to the conduit hub. Since the breaker or switch in the AC panel will be the primary disconnect means for the gas sensor, the AC

panel must be located within 10 ft. of the gas sensor. The gas sensor should be on a circuit that is protected at 15A or less.

5. Pull Ground, Neutral, and Hot wires into the electrical enclosure.
6. Attach the Neutral and Hot wires to the power terminal strip as shown in figure 3.
7. Crimp a #10 ring terminal to the green (ground) wire. Be sure that the terminal is the correct size for the gauge of wire being used. Follow the terminal manufacturer's instructions for preparing and crimping the terminal.

 **CAUTION! – Failure to properly ground the gas sensor can create a high voltage shock hazard. Follow the instructions carefully.**

8. Turn on power to the gas sensor circuit.

Output Signal Connection Procedure

The 4-20mA and serial outputs are supplied from a mating terminal block inside the unit. Connections can be made with a customer supplied cable through the strain relief fitting supplied with the gas sensor or by running the signal wires into the enclosure through a ½" conduit.

 **CAUTION! – Be sure the power to the unit is turned off before opening the gas sensor enclosure and making any connections.**

Note that the 4-20mA outputs are factory set to source current. If a passive current loop is required, the jumper on the current loop board may be moved from the "A" (active) position to the "P" (passive) position.

To connect the 4-20mA and serial outputs through a cable:

1. Disconnect power from the unit.
2. Open the enclosure cover, being careful not to disturb the electrical assembly inside.
3. Thread the signal cable through the strain relief fitting into the enclosure. The strain relief fitting is sized to accommodate cables with outer diameters from 0.31" to 0.56". SpectraSensors recommends that a cable with an individually shielded pair for each signal be used for the signal connections.
4. Strip back the jacket and insulation of the signal cable enough that it can be connected to the mating terminal block.
5. The mating terminal block can be pulled up from its base to make cable connection easier. See figure 6.

6. Table 2 shows the pin number for each of the output signals. Note that there is a single ground connection shared by all of the signals.

Pin #	Signal Description
1	CH1 Serial RX
2	CH1 Serial TX
3	COM Serial Gnd
4	CH2 Serial RX
5	CH2 Serial TX
6	CH1 Current Loop +
7	CH1 Current Loop -
8	CH2 Current Loop +
9	CH2 Current Loop -

Table 2 Output Signal Connections

7. Connect the output wires to the desired terminals. See figure 7.
8. Reinsert the matting terminal block into the base and verify that the terminals are tight. See figure 8.
9. Cinch the strain relief mechanisms so that they are snug with the outside of the enclosure.
10. Close and lock the enclosure cover.

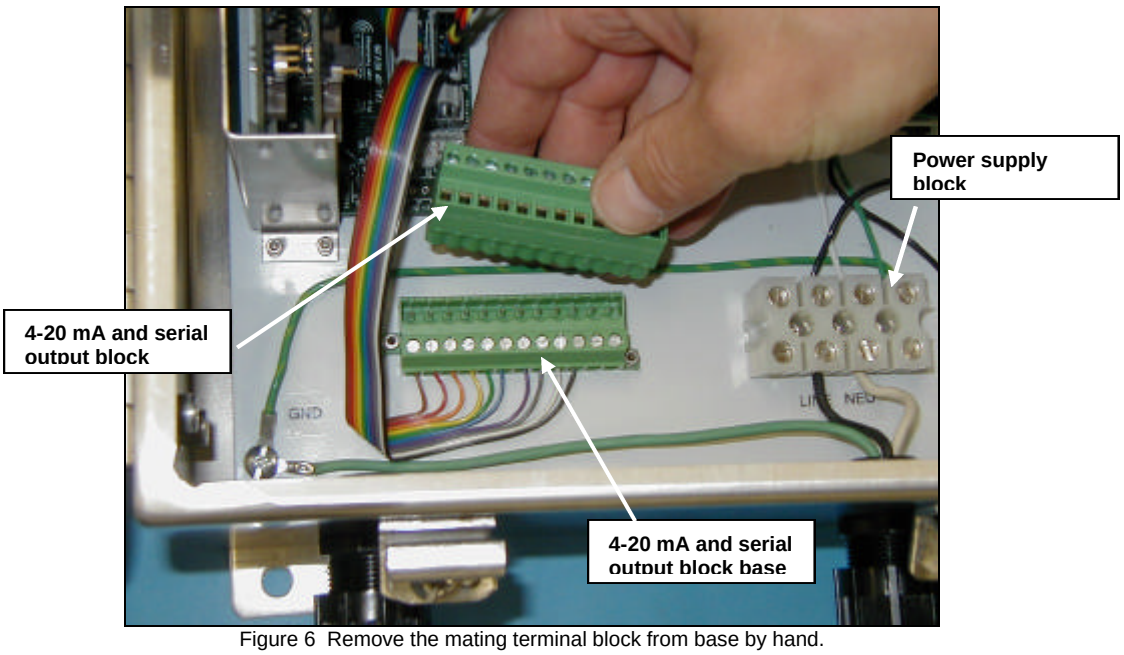


Figure 6 Remove the mating terminal block from base by hand.

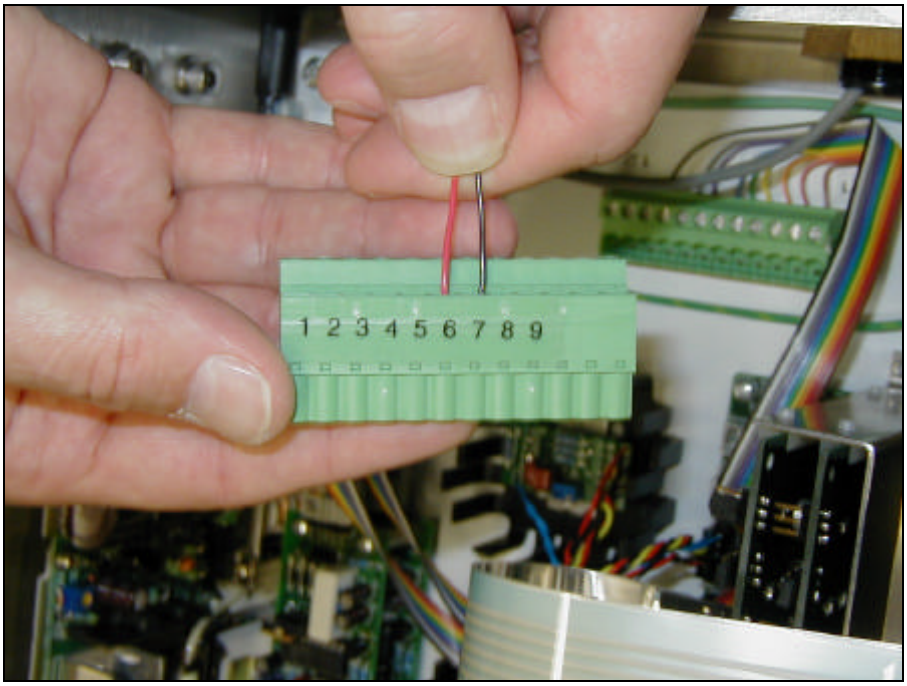


Figure 7 Insert signal wires into terminals as shown in Table 2

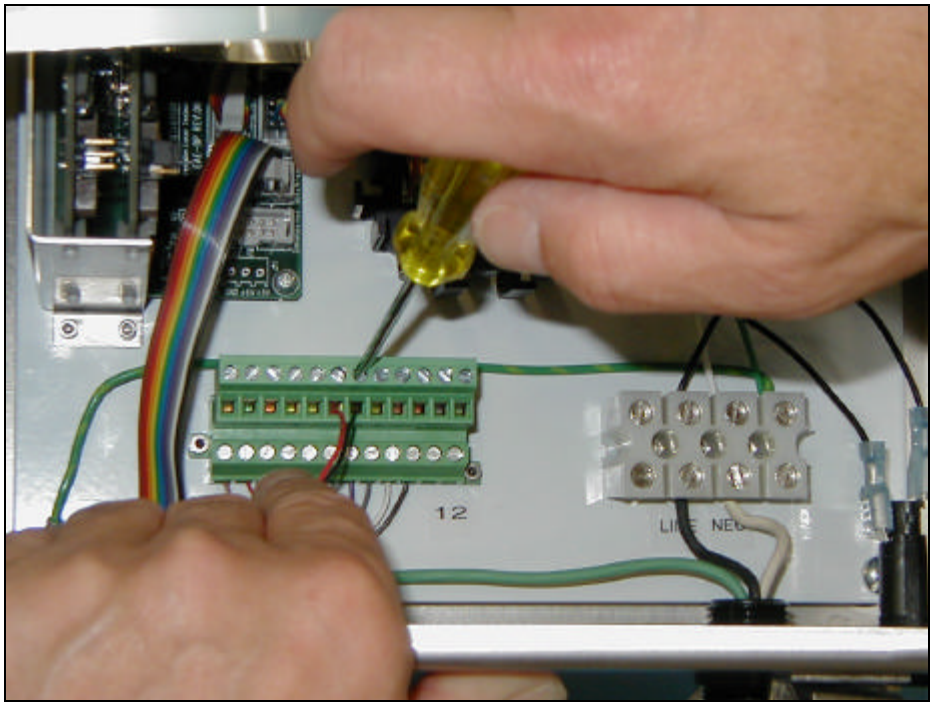


Figure 8 Replace block on base and check all terminals are tight.

To connect the 4-20mA and serial outputs through a cable:

1. Disconnect power from the unit.
2. Open the enclosure cover, being careful not to disturb the electrical assembly inside.
3. Remove the cable strain relief fitting and replace it with a NEMA 4Xrated conduit hub.
4. Run conduit to the gas sensor and pull signal wires through the conduit. SpectraSensors recommends the use of shielded wire to prevent signal interferences.
5. Follow steps 4 through 10 above for connecting the signal wires to the terminal block.

RS-232 Output

The RS-232 presents a string of data to a serial device. The serial device is typically a computer terminal running HypeTerminal or other serial port software. The serial port should be set for 9600 baud, 1 stop bit, no parity, and no handshake. The RX output is connected to pin 3 on the computer's serial input. The TX output is connected to pin 2 on the computer, and the GND is connected to pin 5.

The data string is space delimited with a carriage return at the end of each line. The data are output in the following order:

Water vapor concentration (if a water channel)
Dewpoint (if a water channel)
CO2 concentration (zero unless a CO2 channel is present)
Pressure
Temperature
2F signal
DC signal
Peak Position (Index)
Null

Calibration

The instrument is calibrated at SpectraSensors against standard (assayed) gas mixtures, and should not be adjusted in the field. Unlike aluminum oxide or electrolytic sensors that are in contact with the sample gas, the laser used to make the measurement in the 2000 Series simply passes through the sample cell and there are no sensors in contact with the gas. So drift or contamination from contaminants (such as glycols or amines in the gas phase) is not possible.

If, however, there is any question or doubt about the 2000 Series readings, a calibration using a Certified Master Class Calibration Standard, or a chilled

mirror hygrometer, may be used to verify measurement accuracy. **Note that any H_2O calibrations must be performed with the same type of background gas that is used in normal operation.**

Power Up Sequence

When the 2000 Series gas sensor has been mounted, the gas sampling lines connected and checked for leaks, and the (optional) output signal wires connected, the unit is ready to apply AC power. It is possible to apply AC power before the gas lines are connected to ensure the unit is functional, but ambient air contains levels of water vapor that are much higher than the instrument is designed to measure. Therefore, valid H_2O readings cannot be obtained until sample gas is flowing through the sample cell.

To power up the 2000 Series:

Apply AC power by plugging in the gas sensor (if cord connected) or by energizing the circuit if the gas sensor is hard wired. **Note that there is a 500 mA slow-blow fuse located on the bottom right hand side of the chassis.**

When AC power is applied to the 2000 Series, the system will go through a 15 second initialization period. The LCD on the keypad will display the word INTIALIZING… and then start counting down from 15. The keypad will not respond to key presses during this time period. Allow 3 additional minutes for the 2000 Series to stabilize before recording measurements.

Normal operation is indicated by continuous updates of the measurement parameters on the LCD. See Figure 9. The LCD displays four lines of alphanumeric data.

In the normal operational mode ("Normal Mode"), the LCD readout displays:

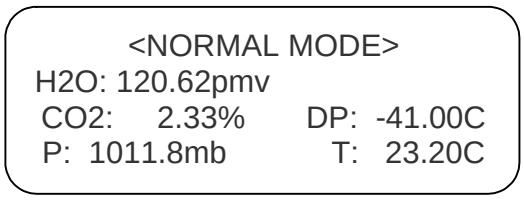


Figure 9 2000 Series LCD on the keypad

Operation

Specifications for Proper Use

The 2000 Series is designed specifically to measure levels of moisture, and carbon dioxide in a gas stream. It also reports dew point, temperature and pressure of the sampled gas.

Although the unit can easily be dismounted and moved from one sampling station to another, it is designed to be a stationary measuring device. It should be securely mounted during normal operation.

Opening of the main enclosure cover is required for installation only. Thereafter, you will rarely need to open the cover of the main enclosure for inspection or maintenance. Subsequent to installation, do not open the enclosure for this purpose unless directed to do so by a service representative.

The measurement heads may be disassembled for cleaning purposes (see the Maintenance Section of this manual). The two main parts of the measurement head are the gas sampling cell and the optical head assembly. The gas sampling cell may be separated from the optical head assembly, and can be further disassembled for mirror cleaning purposes from time to time. In no case, however, will the operator need to disassemble the optical head assembly.

CAUTION! – Note the enclosure seal, used to prevent inadvertent tampering with the device. It is imperative that the operator not attempt to compromise the seal of the optical head assembly enclosure. Doing so will result in loss of device sensitivity and inaccurate measurement data. Repair of this situation must be handled by the factory and is not covered by warranty.

Keypad Functions

The keypad allows the operator to modify certain parameters that control the 2000 Series. However, once the unit has been properly installed and normal operation has been established, there should be no need to alter the operational parameters. Measurements of H_2O, CO_2, Dew Point, Temperature and sample cell Pressure are continuously displayed on the LCD display. For single channel H_2O-only systems, the CO_2 value will always display as zero.

NOTE: To activate any functions on the keypad, press the "#" key and then press a number to select "Mode" or the TEST key. If the "#" key is not pressed before pressing a Mode or function key, there will be no response. When the "#" key is pressed, the word "MODE" will be displayed on the LCD. At this point the unit will wait for a second key to be pressed before responding.

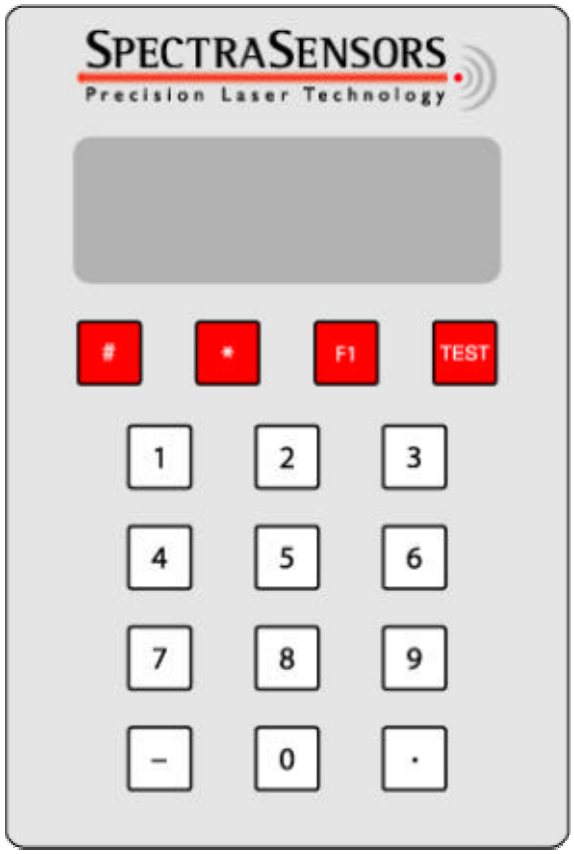


Figure 10 2000 Series Keypad

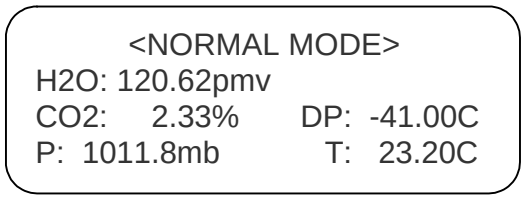
Modes

The following modes can be accessed from the keypad by pressing the "#" key and then entering 1, 2, 3, 4 or "Test".

- Mode 1 is Normal Display Mode.
- Mode 2 provides change of parameters for H2O measurement.
- Mode 3 provides change of parameters for CO2 measurement
- Mode 4 displays System Diagnostic Parameters for H2O
- Mode 5 displays System Diagnostic Parameters for CO2
- Mode 6 outputs spectra and calculations to serial port
- Mode "Test" displays H2O System Test parameters

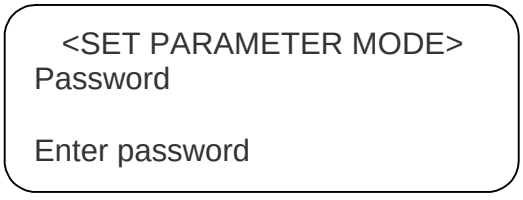
Mode 1 (Normal Display Mode)

Mode 1 continuously displays updated measurements.



Mode 2 (H_2O Measurement Parameter Change)

After pressing the "#" key and then "2" key, the LCD will prompt the user to enter a numeric password.



Enter the user password on the keypad, then press the "*" key.

NOTE: The user password is 3142, the first four digits of the value of π.

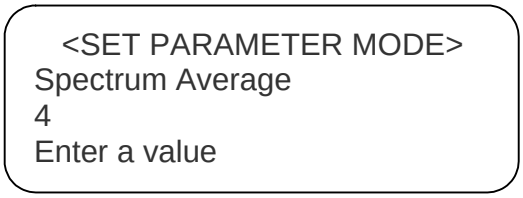
Mode 2 allows the operator to view and change the values of the following H_2O measurement parameters:

Note that prior to setting the zero offset or RCalb parameters, suitable calibration gases must be available, along with the tools necessary to hook them up to the analyzer.

Function	Setting	Function
Spectrum Average	1 – 16 default = 4	Sets the number of scans that are averaged for each 2F spectrum.
RCalb	1000 – 3000	Sets gain calibration for H_2O or CO_2 measurements.
Alarm Action	0 or 1	Determines if the concentration values goes to full scale or zero on an alarm condition.
Zero Offset	0 – 100 ppmv for H_2O, 0-1% for CO_2	Sets the zero offset for H_2O or CO_2 measurements.
Logger Rate	1 – 300 seconds for both H_2O and CO_2	Sets the gas concentration integration time.
Temperature unit	0 or 1	Sets the display unit for Temperature.
Pressure unit	0,1 or 2	Sets the display unit for Pressure.
Concentration unit	0 or 1	Sets the display unit for the water concentration.

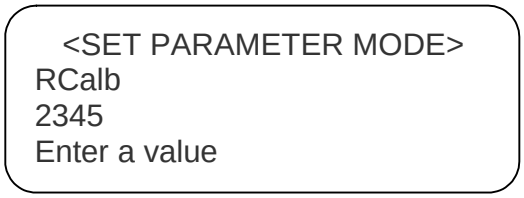
Table 3 2000 Series Keypad

Spectrum Average



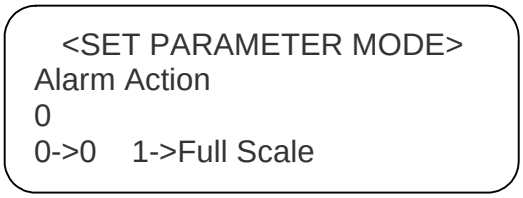
This value is the number of scans that are averaged for a spectrum calculation. The more spectra averaged, the less the noise but the longer the response time. Each spectrum adds about 0.25 sec to the response time.

RCalb



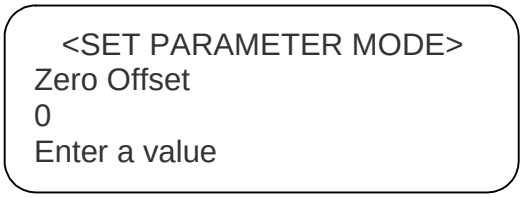
RCalb is the gain calibration factor for the concentration measurement. This number should not be changed from the factory setting unless calibration equipment is available and a full calibration procedure is followed.

Alarm Action



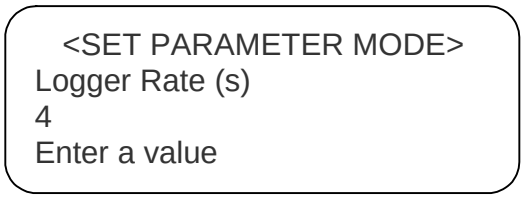
This value determines whether the concentration value is set to zero or full scale in the event of an alarm condition.

Zero Offset



For concentration measurements it is necessary to compensate for small amounts of background gas that adsorb some laser light, causing an offset to be introduced into the measurements. This number should not be changed from the factory setting unless calibration equipment is available and a full calibration procedure is followed.

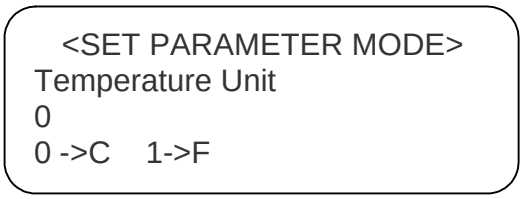
Logger Rate



For applications where an external data logger is used: Logger Rate allows the operator to set the averaging time period used by the analyzer to match the data logger rate. Longer periods results in "cleaner" data because of the effects of the signal averaging. For example, if you are logging data every minute, it does not make sense to have the analyzer report the data every second because only one data point every 60 seconds is being collected by the data logger. By changing the value entered for the Logger Rate, the analyzer output can be matched to the data logger sample rate, resulting in optimum signal averaging. The setting can vary from 1 to 300 seconds.

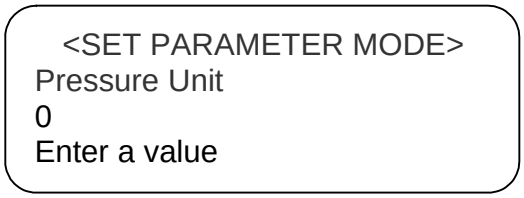
Enter a numeric value (in seconds) and press the "*" key to accept the new value. The system will cycle to the next adjustable parameter. If no changes are desired to the Logger Rate, just press the "*" key.

Temperature Unit



This enables the user to choose the unit to display for temperature measurement and dew point. Choose between °C or °F. The default value is °C. When the "*" key is pressed, the display will cycle to the next parameter.

Pressure Unit

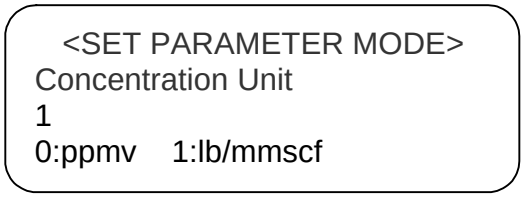


This enables you to choose the unit to display for Pressure measurement. Choose among the following choices:

- Press 0 for millibar
- Press 1 for Torr
- Press 2 for Pascal
- Press 4 for Pounds per Square Inch Absolute

When the “*” key is pressed the LCD will cycle to Concentration unit.

Concentration Unit



This enables you to choose the unit to display for water concentration. For H2O concentration display there are the following options:

- Press 0 for ppmv
- Press 1 for Lb/mmscf

This is the last parameter. Press # + 1 to return to Normal Measurement Mode.

Mode 3 (CO_2 Measurement Parameter Change)

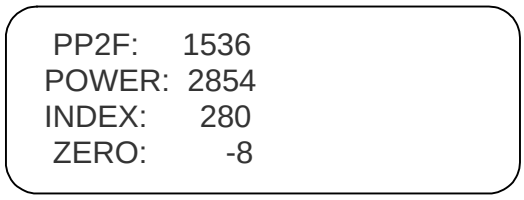
When CO2 is not being measured the Normal Mode will be displayed.

Mode 3 allows the operator to access and change parameters for CO_2 measurements in the same manner as Mode 2 is used to alter the parameters for the H_2O channel. The menus for Mode 2 and Mode 3 are identical. The only difference is the unit of measurement used when entering parameters.

For CO_2 the Zero Offset and Span Limit parameters must be entered in percent, while for H2O these values are entered in either ppmv (Zero Offset) or lbs/MMscf (span limit). Follow the instructions for Mode 2. These numbers should not be changed from the factory setting unless calibration equipment is available and a full calibration procedure is followed.

Mode 4 (System Diagnostic Parameters for Water)

Mode 4 displays System Diagnostic Data for water. These values may be useful when trouble shooting the system.



PP2F shows the value of the concentration signal is A/D counts. A normal range is 0 to 6000 depending on the concentration of water present.

Power show the laser power detected at the absorption peak. Acceptable limits are 1000 to 4000. A low number may indicate that the optics require cleaning.

Index is the position of the absorption peak within the wavelength scan. It should normally be between 250 and 350.

Zero is the detector signal value when the laser is turned off. It should be in the range of –40 to + 40.

Mode 5 (System Diagnostic Parameters for CO2)

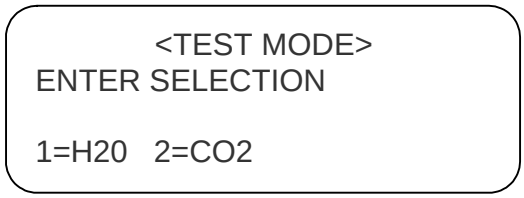
Mode 5 displays the System Diagnostic Parameters for CO2. The description and normal ranges are the same as for Mode 4.

Function Key

The Function Key F1 is reserved for factory and service personnel diagnostics. It is not meant to be used by operators, although depression of this key will not result in any affect on the device for the user.

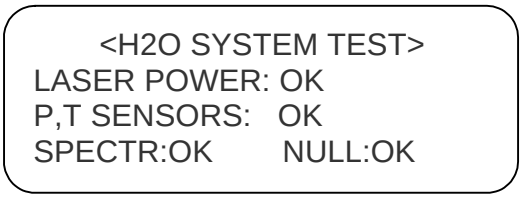
Test Key

The TEST key provides basic diagnostic test results for laser power, pressure and temperature sensors, and the infrared spectrum that is recorded by the system for analysis. The LCD will display the following for a dual-channel system.

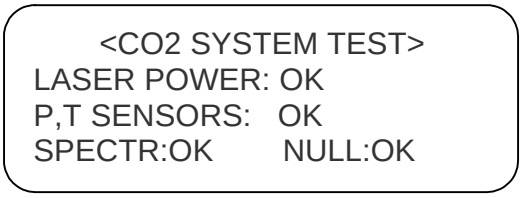


Select the entry for the channel you want to display. In the case of a single channel system, this screen is not shown and one of the screens below will be displayed instead.

To view the water channel press “1” and the LCD will display the following:



To view the carbon dioxide channel press “2” and the LCD will display the following:



If a failure is detected, the LCD will display “FAIL” for that component. If the LCD displays a failure for one or more of the components, refer to the troubleshooting section.

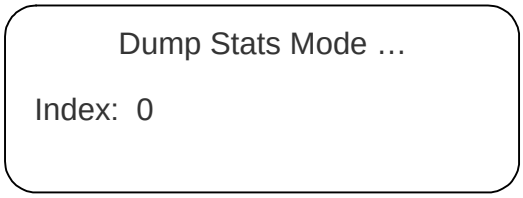
Mode 6 (Diagnostic Data Dump)

This mode is used to output to the serial ports the individual data points of both the DC and PP2F spectra that are analyzed by the instrument to calculate the gas concentration. Viewing these data can be helpful in diagnosing potential problem with the instrument. The data points, along with intermediate calculation results, are output to the serial ports whenever mode 6 is selected. The data for the H2O channel is output on the H2O serial port and the data for CO2 (in a two channel unit) is output on the CO2 serial port. See page 15 of the Operators Manual for wiring and protocol information for the serial ports.

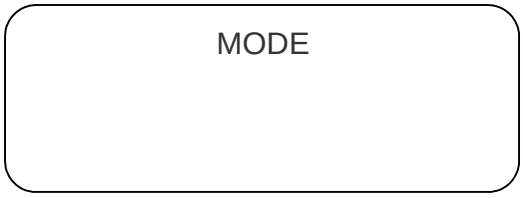
Any computer terminal program that works with the RS-232 serial port can capture the serial port data. The Hyperterminal program included with Microsoft Windows is a typical example of such a program. Before entering Mode 6, the serial port should be connected to the computer being used for monitoring the serial port and the output stream should be showing on the screen. The number of seconds between each line of data output should be the Spectrum Average number set in Mode 2 divided by 4. The factory default setting of Spectrum Average = 4 gives a line of output each second. To save the data from the serial port, use the capture feature on the terminal

program. (For Hyperterminal, use the Transfer/Capture Text function and enter a file name to identify the data to be captured.) Once capturing is taking place, enter mode six by pressing:

Mode 6 will display:



The index will count by 50s from 0 to 511 in a few seconds and the screen will display:



Press 1 to return to normal operation.

When normal operation has resumed, stop the capture of the serial data. (For the Hyperterminal program, press Transfer/Capture Text/Stop.) This file can be imported into a spreadsheet program such as Excel and the data plotted.

At the end of the spectrum data, there is a section that displays the intermediate calculations. This information can be valuable to the factory if troubleshooting is necessary.

Power-down Procedure

The power-down procedure is simple. Remove the power cable from the AC outlet or disconnect power from the gas sensor circuit in the case of a hardwired system. There is no specific sequence beyond that for shutting down 2000 Series gas sensors.

If the unit is going to be shut down for some time, it is recommended that the sampling gas line shut-off valve be turned off. Also, disconnect AC power to prevent damage from lightning strikes.

Maintenance

The 2000 Series requires very little regularly scheduled maintenance. In fact, the unit itself requires no maintenance that can be performed by the user. However, there are some external conditions that can affect the measurement

Reducing Contamination of Gas Sampling Lines

Contamination in the gas sampling lines can contaminate the optics and absorption cell causing problems. To keep the sampling lines clean and improve response at very low humidity:

1. Make sure the coalescing filter is operating and replace if necessary. Small amounts of glycol or amine in the gas phase should not cause problems as they will be swept out of the sample region by the gas flow and they do not affect the measurement in any way. But if liquid enters the cell and accumulates on the internal optics the system will not operate correctly. Pressure # + TEST on the keypad will indicate a failure in laser power if the mirrors become contaminated.
2. Disconnect the gas sampling inlet and outlet lines from their respective connections on the 2000 Series.
3. Wash the sampling lines with water or acetone and blow-dry with mild pressure from a dry air or nitrogen source. It may be desirable to heat the lines for a few minutes to clear residual water from the lines.
4. Reconnect the gas sampling lines by tightening the connection finger tight and then tightening an additional ¾ turn with a 9/16-in. open-end wrench.

Procedure for Cleaning Contaminated Mirrors

The 2000 Series is intended to measure very clean low water content gas (no more than 20 lbs/MMscf). SpectraSensors has other models available that are capable of measuring gas with higher moisture concentration. **The sample gas inlet line must have a coalescing filter to prevent contamination of the internal optical components.** Although the SpectraSensors Series 2000 gas sensor can tolerate significant loss of reflectivity from its mirror, it may still be necessary to clean the optics. Should gross contamination occur, such as in the case of a filter failure, the optics may become severely contaminated and the mirrors inside the sampling cells must be cleaned. If you cannot or do not desire to clean the mirrors, your local representative can provide on-site service for a small fee.

Note that if the gas sensor has become contaminated, the tubing and instrumentation up stream of the sensor is likely to be contaminated as well. Be sure to clean or replace these parts when the sensor is cleaned to prevent recontamination of the sensor.

CAUTION! – It is extremely important that disassembly of the measurement cell take place in a clean area so that dirt or other

contaminants do not get on the optical components during the cleaning operation. In addition, the area should be well ventilated and personnel should wear protective gear to prevent accidental contact with cleaning solvent. Read the directions on the solvent before using.

Be careful not to touch any of the optical surfaces.

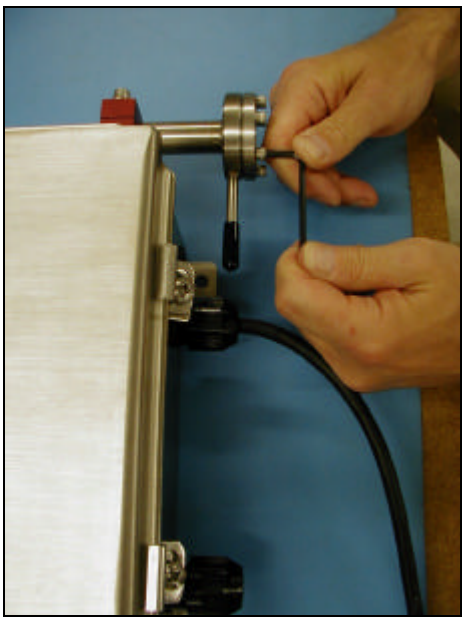
Do not use air from an air compressor to blow off the optics. It may contain either liquid or solid contaminants and the high velocity of some nozzles may propel dust into the mirror surface. Always remove power from the equipment before cleaning.

Method:

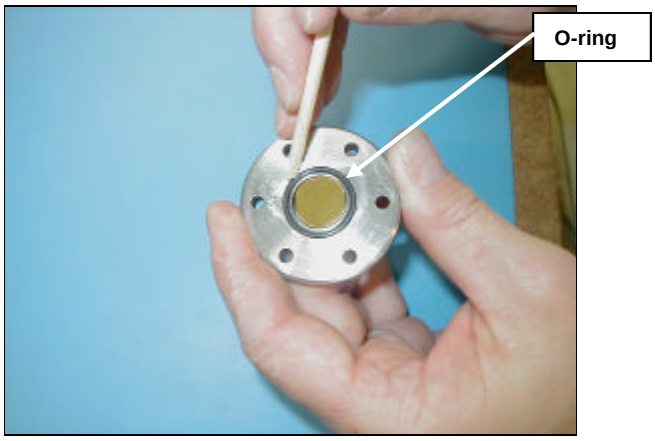
SpectraSensors recommends using a solvent rinse cleaning process to avoid the possibility of scratching the optics. In most cases this should be sufficient to restore the optics to usable condition. A suitable cleaning kit is available from your local sales representative. The kit includes mirror safe spray solvent, an ultra pure air duster, lint free wipes, non-outgasing o-ring grease, hex wrench, spare screws and washers, and spare fuses.

Process (see illustrations where shown for each step):

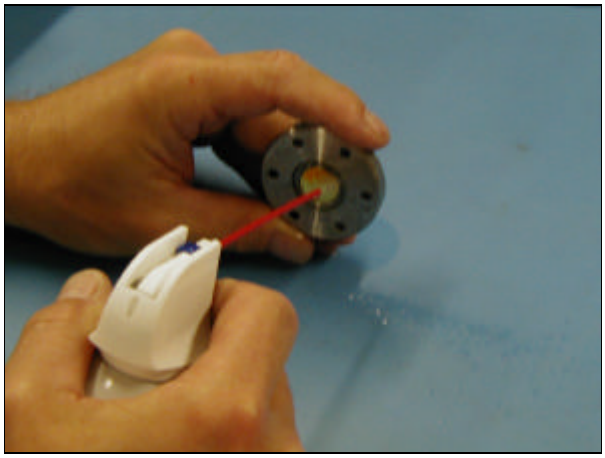
1. Mark the mirror flange and the end flange of the sample cell so that the mirror can be reinstalled with the same rotation.
2. Remove the six screws holding the mirror assembly to the bottom of the sample cell. Note the arrangement of the washers, lock washers, and nuts so that the flange can be attached the same way on reassembly.



3. Carefully remove the o-ring from the mirror assembly and place it on a clean surface.

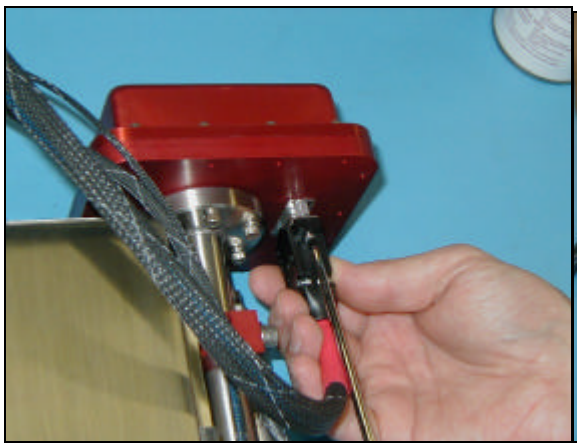


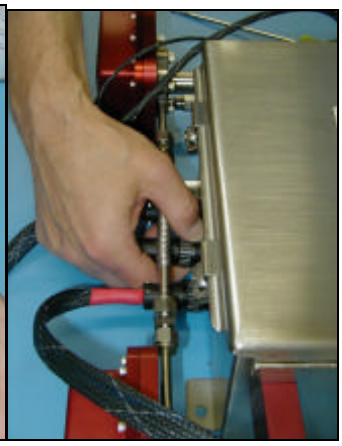
4. Hold the mirror assembly over a sink or bucket (test bucket first to ensure compatibility with the solvent) to catch any drips. Position the mirror vertically so that the solvent flows down the surface of the mirror when it is sprayed. Hold the solvent can vertically while spraying. Gently spray the surface of the mirror and flange starting from the top and flushing the solvent down while spraying. Less than five seconds of spraying should be sufficient to clean normal contamination from the mirror. **Do not touch the mirror with the spray nozzle.**



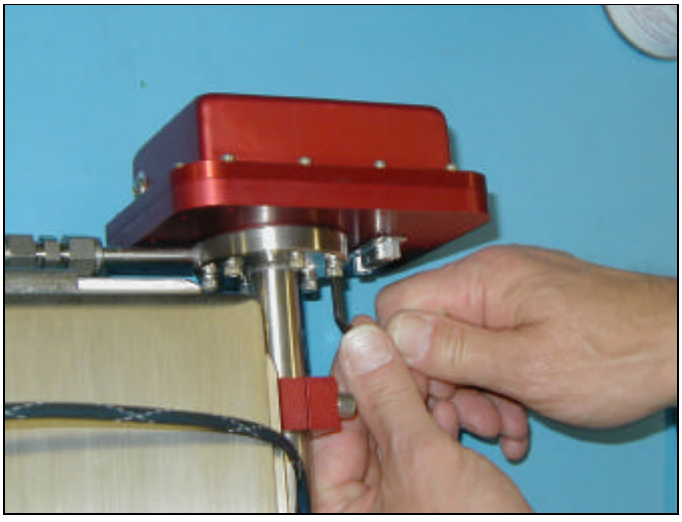
5. Allow the solvent residue to evaporate from the mirror surface. Inspect the mirror for residual contamination. If contamination is not completely removed, repeat the spraying process.
6. When the mirror looks clean, blow off any solvent that has been trapped in the space between the mirror and flange using the air duster can.
7. Set the mirror assembly aside in a clean area.
8. Gently spray some solvent onto the o-ring and wipe it clean with a clean, dry, lint-free wipe.
9. Put a small dab of non-outgasing grease on the o-ring and wipe it off.

10. Replace the o-ring into the mirror assembly. Do not touch the mirror with the o-ring.
11. Disconnect the measurement head cables from the top of the control box. (One cable is for the optical head and the other, if applicable, is for the temperature and pressure probes.)

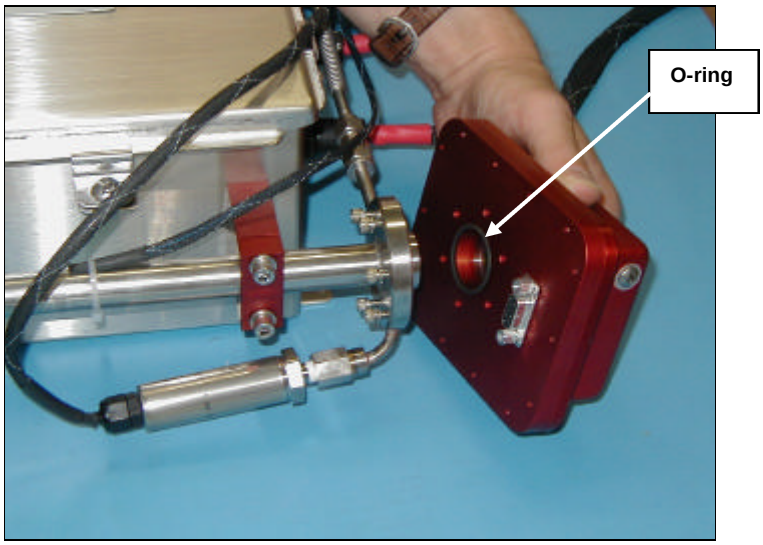




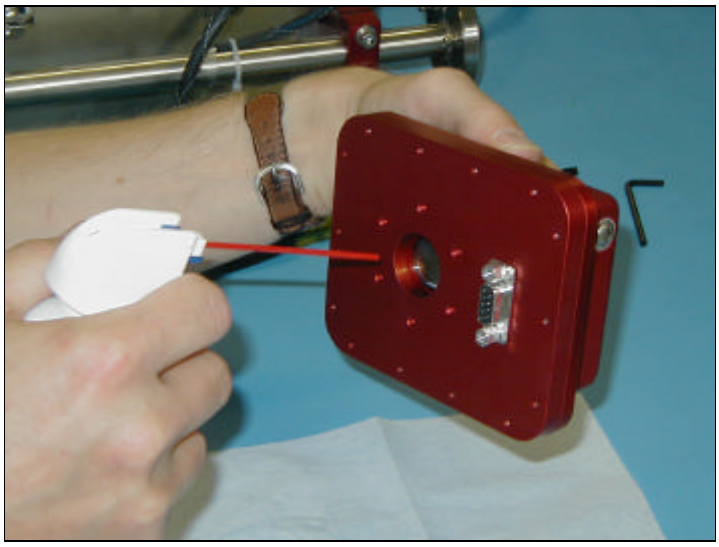
12. Remove the six screws holding the optical head assembly to the top of the sample cell. Note the arrangement of the washers and lock washers so that the flange can be attached the same way on reassembly.



13. Leave the o-ring in the top of the flange on the sample cell.



14. Clean the window on the bottom of the optical head assembly using the same procedure as for cleaning the mirror.



15. Position a bucket below the sample cell on the side of the electronics box. Flush the inlet tube, outlet tube, and the inside walls of the sample cell with the solvent, letting it drip down into the bucket.
16. After flushing for 5 to 10 seconds, blow off any residual solvent residue.
17. Re-attach the optical head assembly to the top of the sample cell.
18. Re-attach the mirror assembly to the bottom of the sample cell, aligning it the same way it was to begin with.
19. Re-connect the measurement head cables.
20. The gas sensor is now ready to power up.

Troubleshooting

Gas Leaks

Probably the most common cause of erroneous measurements is outside air leaking into the inlet sampling line. It is recommended the inlet lines be leak-tested periodically, especially if the unit has been relocated or if the unit has been replaced or returned to the factory for service and the sample lines have been reconnected.

High Humidity

High humidity or condensation of water may cause temporarily high readings. If the 2000 Series is exposed to these conditions for long periods of time, sampling lines may take a long time to completely outgas. Sufficient time should be allowed for the walls of the absorption cell to dry completely before the 2000 Series will return to making accurate measurements, especially when measuring frost points below -70°C (-94°F).

Humidity levels higher than expected may be caused by leaks in the sample system or tubing leading to the analyzer. All wetted parts should be of stainless steel wherever possible. Materials such as vinyl, rubber, or PVC will dramatically impair the measurement performance of the instrument and will impact upon accuracy. Pressure regulators installed upstream of the analyzer should be of high quality and fitted with stainless steel diaphragms.

Any hygroscopic material (dust) in the lines or absorption chamber can further increase the time needed to return the measurements to normal levels.

Contamination and long exposure to high humidity are valid reasons for cleaning the gas sampling lines periodically (as outlined above).

Excessive Sampling Gas Temperatures and Pressures

Errors can also arise from absorption cell temperature and pressure that exceed the ranges allowed by the software. These ranges are 0.7 to 1.7 bar (10.3 to 25.0 PSI.) for pressure and –40 to +50°C (-40 to 122 °F) for temperature. Inlet sampling gas temperatures and pressures must stay within these ranges in order to obtain accurate measurements.

Electrical Noise

High levels of electrical noise can interfere with laser operation and cause it to become unstable. The 2000 Series should never be operated with the front cover open (*see Warranty*), and should always be connected to a properly grounded AC power source.

NOTE: If the pressure and temperature readings (or *any* readings) on the LCD are suspect, they should be checked against the specifications in the Specifications Sheet in the Operations section of this manual.

Further Undetectable Problems

If the above issues do not seem to be affecting a suspected problem with the Series 2000 gas sensor, the user should consult the following final self-troubleshooting guide before contacting a sales representative for service.

Table 3 Final Troubleshooting Table

Symptom	Response
Non-Operation (at start up): Non-Operation (after start up):	Is the AC power connected to both 2000 Series and AC power source? Switch On?
	Is the AC power source good? (100 to 250 VAC @ 50-60 Hz)
	Check fuse.
	Contact sales representative for further troubleshooting.
Power Fail Error	Check optical head cable connections. **Do not disconnect or reconnect any optical head cables with the power connected.**
	Possible mirror contamination issue. See maintenance section for cleaning procedure.
	If you cannot, or do not desire to clean mirrors, contact sales representative for service.
Spectrum Fail Error	Check optical head cable connections. **Do not disconnect or reconnect any optical head cables with the power connected.**
	Contact sales representative.
P/T Fail Error	Check Pressure/Temperature cable connections.
	Contact sales representative.
Test button on keypad indicates a failed component.	Contact sales representative.
LCD display does not update. Unit is locked up.	Switch off AC power, wait for 30 seconds, then switch AC power back on.

Warranty

The Manufacturer warrants the items delivered shall be free from defects (latent and patent) in material and workmanship for a period of one year after delivery to the Buyer. The Buyer's sole and exclusive remedy under this warranty shall be limited to repair or replacement. Defective goods must be returned to the Manufacturer and/or its Distributor for valid warranty claims. This warranty shall become inapplicable in instances where the items have been misused or otherwise subjected to negligence by the Buyer.

Notwithstanding any other provision of this contract, no other warranties, whether statutory or arising by operation of law, expressed or implied, including but not limited to those of merchantability or fitness for particular purpose, shall apply to the goods or services hereunder, other than the repair and replacement warranty above. Seller shall in no event be liable to buyer or any third party for any damage, injury or loss, including loss of use or any direct or indirect incidental or consequential damages of any kind.

Disclaimer

SpectraSensors accepts no responsibility for consequential damages arising from the use of this equipment. Liability is limited to replacement and/or repair of defective components.

